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(54) A METHOD AND APPARATUS FOR LEAK DETECTION

(57) A method and apparatus of testing the integrity of a hollow article 12 having an opening 22 therein, by a leak detection procedure. The article 12 is placed in a test chamber 1 with the opening exposed and the chamber sealed. The chamber 1 is then evacuated (6). A closure device 13, 21 mounted on the wall 4 of the test chamber is then operated from outside the chamber to close the opening 22 in a vacuum-tight manner. Evacuation is then continued of either the interior of the article or the space within the chamber surrounding the article to produce a pressure differential across the wall of the article. A test gas 19 is admitted to the region of higher pressure and a test gas detector 8 is connected to the region of lower pressure. Connections to the interior of the article may be made through the closure device 13.

If the article is substantially cylindrical i.e. has a second opening opposite the first opening 22, a seal 43 on the floor of the test chamber can be used to seal the second opening.

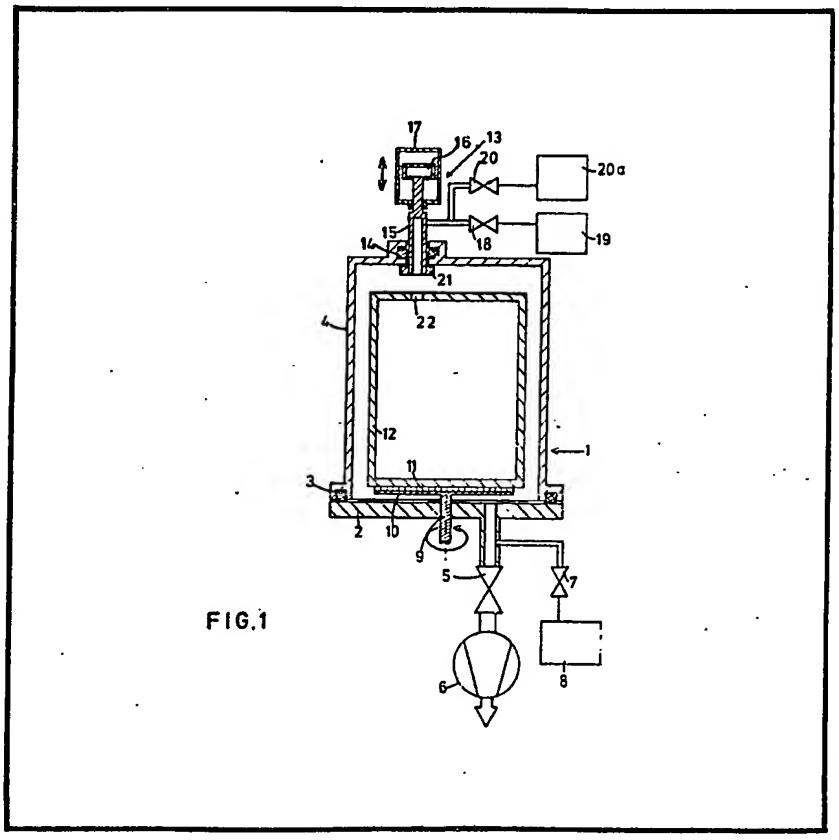

FIG.1

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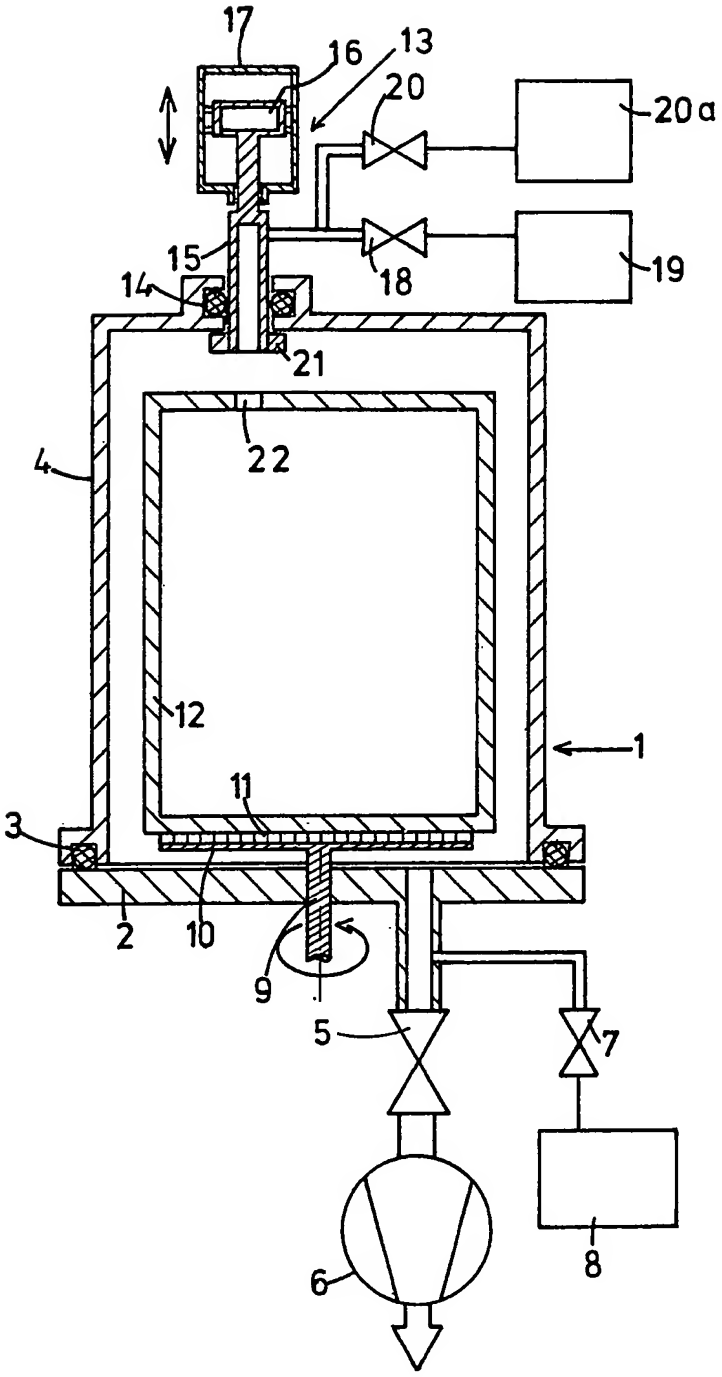

FIG.1

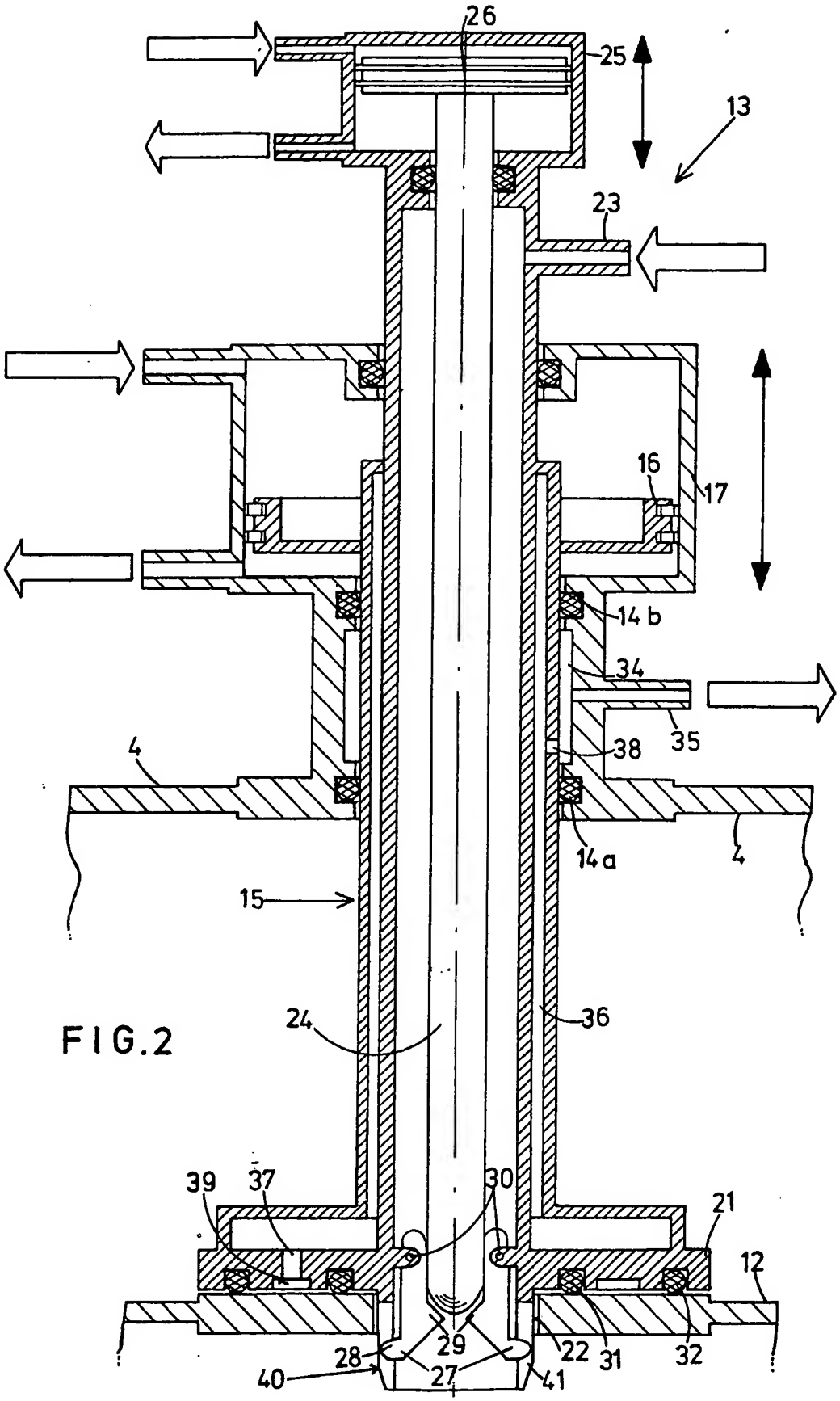
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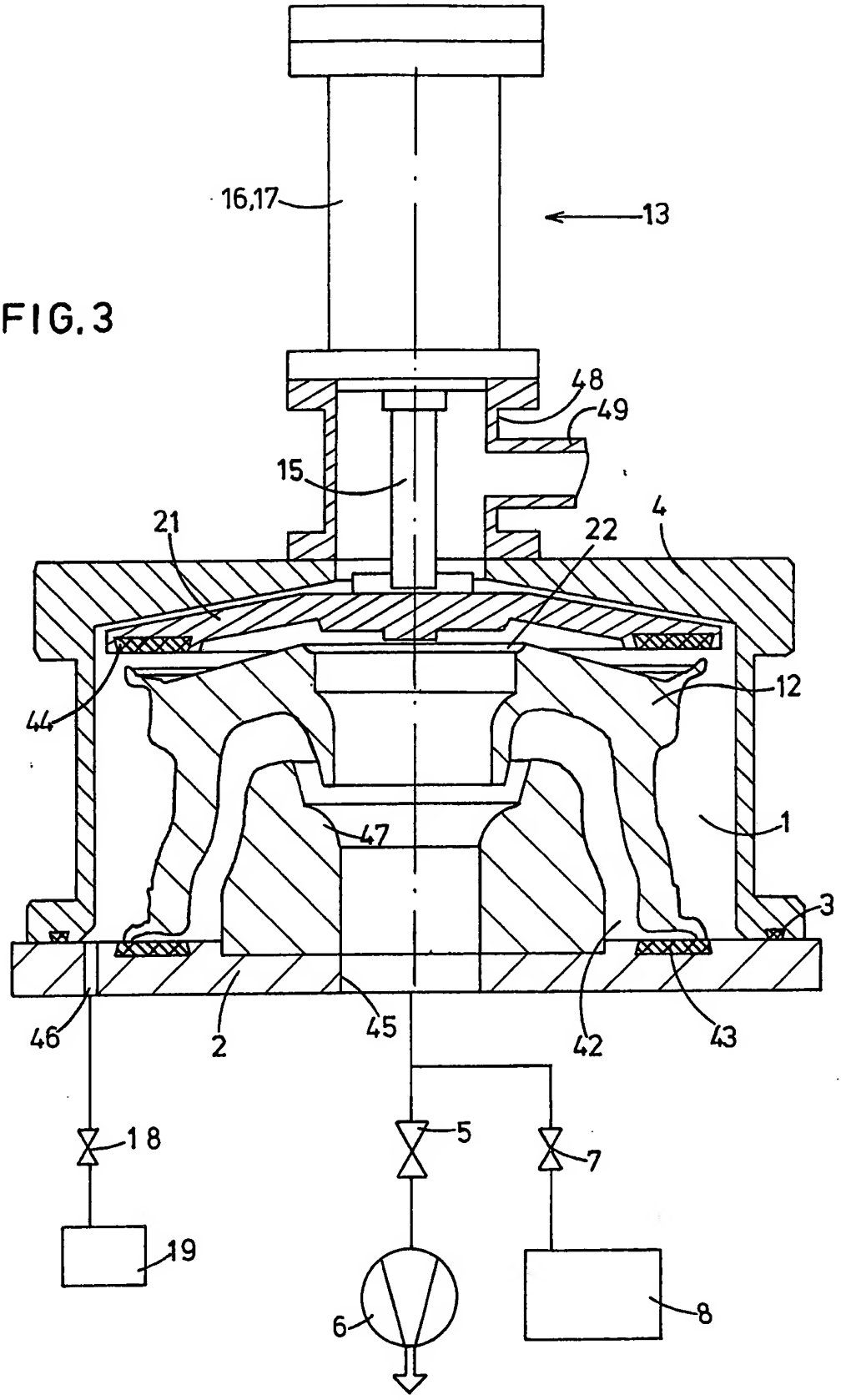
FIG.2

FIG.3



SPECIFICATION

A METHOD AND APPARATUS FOR LEAK DETECTION

The invention relates to a method and apparatus for testing the integrity of hollow articles having at least one opening therein, such as vessels, barrels, casks, cylinders or tubular articles by a leak detection procedure.

It is becoming increasingly desirable to subject articles of this type to a careful leak detection test immediately after they have been manufactured to ensure they are resistant to penetration by fluids to which they will be exposed in use. The technical effort and time spent on this leak detection is higher the greater the production capacity and the more sensitive the leak detection.

It is known to test articles of the aforementioned type integrally for leaks. In the case of integral leak detection the test article is placed in a test chamber and the test article and the test chamber are then evacuated by means of an evacuation system in such a way that a pressure difference is formed across the walls of the test article; a test gas is then admitted on the high pressure side and any penetration of the test gas through to the low pressure side is detected with a detector sensitive to the test gas.

An integral leak detection device is known for example from German Offenlegungsschrift 2 403 360. With the German apparatus disclosed, a test article provided with a flange connection is first of all connected, with its opening directed downwards, to a line for evacuating the said test article. A hood is then placed over the test article so as to form a sealed test chamber which is evacuated via a further connection line. An integral leak detection test is then carried out on the test article.

This prior art apparatus is completely unsuited for use in production plants having a high production capacity. In the present context, the term production capacity denotes the number of articles produced per minute. Even flange-connecting the article to be be tested to the evacuation system would take several minutes. Since in addition the opening of the test article is provided with connecting elements that "throttle" the pumping capacity of the evacuation system, the time required to evacuate the test article as well as the interior of the test chamber to a predetermined pressure is relatively long. In addition, there is the danger that, in the case of separate — and even in the case of simultaneous — evacuation of the test article and the remaining contents of the test chamber, a maximum pressure difference will be exceeded which the walls of the test article, which are frequently made of plastics material or thin steel sheeting, cannot withstand. The permissible differential pressure would, for example, be exceeded if the test chamber were not tightly sealed.

Finally, the prior art apparatus is unsuitable for articles that are only approximately cylindrical in shape, and thus have a relatively large opening at the top and bottom. Such test articles may, for example, be car wheel rims or the like. These have no flange connections that can be connected to any types of lines.

The object of the present invention is to provide a method and apparatus for integral leak detection that will allow fast cycle times and in which, moreover, there is no longer the danger that the permissible differential pressure will be exceeded.

In accordance with the invention, there is provided a method of testing the integrity of a hollow article by a leak detection procedure, the article having an opening therein, which comprises placing the article in a test chamber with the opening exposed, evacuating the test chamber and hence also the interior of the article, operating a closure device from outside the chamber to close the opening and seal the space inside of the article from the remaining space in the chamber surrounding the article, continuing evacuation of one of said spaces to produce a pressure differential between said spaces and across the wall of the article, admitting a test gas to the space at the higher pressure, and connecting a test gas detector to the space at the lower pressure to test for the presence of test gas therein.

With this method it is thus no longer necessary to flange connect the test article in a time-consuming and costly manner to an evacuation apparatus before placing the said test article in the test chamber. After closing the test chamber the opening of the vessel is not constricted by connection devices and accordingly it is possible to evacuate the test article very rapidly. Since the test article and test chamber are evacuated simultaneously, there is no danger that the permissible differential pressure will be exceeded. The rapid evacuation of the test article and test chamber to relatively low pressures has in addition the extra advantage that high requirements as regards sensitivity can be placed on the leak detection since the integral leak detection is more sensitive the lower the pressure level at which the detection is carried out.

A method of this type is in particular also suitable for leak detection at high cycle times on substantially cylindrically shaped test articles, e.g. car wheel rims. With such types of test articles it simply has to be ensured that the side of the test article situated opposite the closure device is likewise closed during the leak detection.

The test article may conveniently also be connected via the closure device to a test gas source or a test gas detector.

Further advantageous features of the method are that in order to ventilate the test chamber and test article after the actual leak detection procedure, the differential pressure may be first equalised, the interior of the test article and the interior of the test chamber may then be connected by withdrawing the closure device, so that both spaces can then be simultaneously ventilated. These measures furthermore have the advantage that unallowable differential pressure

admitted via the valve 20 until the required test differential pressure is reached. This compressed gas can be used to increase the differential pressure and to save test gas. After these steps the valve 7 is opened and the test gas detector 8 is thereby connected. If there is a leak in the vessel 12 test gas will penetrate into the text chamber 1 and be recorded by the detector 8.

In the embodiment described the integral leak detection is carried out from the inside to the outside across the walls of the test article 12. The leak test can also be carried out in the reverse manner by transposing the detector 8 and the test or compressed gas source 19, 20a. The leak detection is then carried out by evacuating the test chamber 1 and the test article 12 together in the manner described above down to the required pressure. The test article 12 is then closed by means of the plunger 15 and test and compressed gas is admitted into the test chamber to produce the required differential pressure. The leak test is then carried out in this case by means of the test gas detector 8 connected via the hollow plunger 15.

Fig. 2 shows an exemplary construction of the closure device 13 on an enlarged scale, and in particular in the position in which the sealing element 21 is placed on the test article 12 and seals the opening 22. It can be seen that the plunger 15 can execute a reciprocatory movement by means of a pneumatically actuable piston and cylinder 16, 17. The plunger 15 is hollow and opens out into the interior of the vessel 12. Depending on the manner in which the leak detection procedure is carried out, test gas and optionally compressed gas can be added, or the test gas detector can be connected, via a connection pipe 23. A rod 24 is accommodated in the plunger 15 and is associated at its upper end with a cylinder piston device 25, 26, likewise pneumatically actuable, so that the rod 24 can execute a reciprocatory movement relative to the plunger 15.

To the lower end of the rod 24 is connected a plurality of hook-shaped levers 27 swivellably mounted at their upper ends on shafts 30. The levers 27 have outwardly directed segments 28 on their lower side. These levers are retained in the position shown by spring pressure (the springs are not shown) when the rod 24 assumes its upper position. If the rod 24 moves downwardly, then the lower end of the rod 24 presses against the inner lugs 29 on the levers 27 and urges the levers 27 outwardly in such a way that the segments 28 abut against the wall of the test article 12 from underneath and thereby produce pressure to close the sealing element 21. The sealing element is formed to provide a double seal with two sealing rings 31 and 32 arranged in grooves in the sealing element 21.

The plunger 15 also is sealed with respect to the hood 4 by means of a double seal comprising sealing rings 14*a* and 14*b*. The rings 14*a* and 14*b* form a chamber 34 which can be evacuated via the connection pipe 35. Such a double seal arrangement with intermediate evacuation is particularly effective. Moreover, the plunger 15 itself has a double wall which forms a chamber 36 connected via an opening 37 in the sealing element 21 with the space 39 formed between the sealing rings 31 and 32. An opening 38 is also provided in the external wall of the plunger 15 located in the region of the chamber 34. These openings 37 and 38 have the effect the seal acting as a closure for the opening 22 also has an intermediate suction or draw-off, and is thereby particularly efficient.

The lower end of the plunger 15 also has a centring pipe 40 which projects into the opening 22 in the attachment position on the test article 12. Slits 41 are provided in this pipe for guiding the levers 27.

The embodiment illustrated in Figure 3 is suitable for leak testing of articles of substantially cylindrical or tubular articles such as car wheel rims which have openings at opposite ends. Thus, not only does the upper opening 22 have to be closed by means of the flange-type sealing element 21, but in addition the lower opening 42 has to be closed before the leak detection test. For this, sealing ring 43 is provided in the floor 2 for the lower edge of the wheel rim 12 to rest on. The ring 43 is made relatively wide to accommodate several wheel rim sizes. A suitably wide sealing ring 44 is also provided in the flange-like sealing element 21. By means of the cylinder and piston device 16, 17 the sealing element 21 is pressed against the rim 12 via the plunger 15, thereby separating the interior of the wheel rim from the exterior. The vacuum pump 6 and the test gas detection apparatus 8 are connected to the interior of the wheel rim by means of an opening 45 in the floor 2. Test gas is admitted via a suitably arranged opening 46 in the floor 2 to the outer space enclosed between the hood and wheel rim. Finally, the floor 2 has a moulded body 47 projecting into the interior of the wheel rim 12, which considerably reduces the existing dead space and thereby enables a more rapid evacuation and a quicker leak detection to be carried out.

In the embodiment illustrated, the cylinder and piston device 16, 17 is mounted on the hood 4 via a connection pipe 48. A connection line 49 opens out into this connection pipe 48, and after the leak detection test has been carried out gas may be blown through the line in order to flush out any test gas residues that are still present, since these could falsify the next leak detection test.

The leak detection is carried out in the manner described with respect to Fig. 1. The test article is placed in the test chamber, the hood 4 is placed on the floor 2 with the sealing element 21 raised, and the interior of the hood is then evacuated. The sealing element 21 is next placed on the upper edge of the wheel rim so as to form two separate spaces that are separated by the wall of the wheel rim being tested. The actual leak detection is then carried out after this step in the manner already described. Since relatively broad sealing rings 43 and 44 are present and the path of the sealing element 21 is relatively great, the apparatus is suitable for wheel rims or other test articles of

overshooting does no occur. For the case where the test gas for the leak detection procedure is admitted into the test article, there is also the advantage that comparatively large amounts of test gas are prevented from passing from the interior of the test article into the test chamber during ventilation.

Apparatus suitable for carrying out the method according to the invention comprises a test chamber for accommodating an article to be tested, means for evacuating the test chamber, a closure device within the test chamber operable to close the opening in the article and thereby seal the space inside the article from the remaining space in the chamber surrounding the article, means operable from outside the test chamber for actuating the closure device, means for admitting a test gas to one of said spaces and a test gas detector connectible to the other of said spaces.

The closure device can be arranged at any suitable point on the test chamber wall. It is conveniently arranged at the point where the opening of the test article is situated after the latter has been placed in the test chamber. In addition, the closure device can serve to connect a line to the interior of the test article. Finally, the closure device can easily be adapted to openings of any arbitrary size in test articles.

If the test chamber consists of a floor with a removable hood, when the closure device may, for example, easily be arranged on the hood. The mobility of the hood is not thereby hindered. If the closure device also serves to connect a line to the interior of the test article (either for admission of test gas or connection to the test gas detector), then if this has a relatively small cross-section it accordingly interferes only slightly with the mobility of the hood. Evacuation lines of large cross-section that would greatly interfere with the flexibility of the hood are conveniently connected to the fixed floor of the test chamber.

The closure device conveniently consists of a plunger passing in a gas-tight manner through the test chamber wall and having a flange-type sealing element for engaging the test article. In the case of test articles having stable walls the necessary degree of gas tightness can be produced by a specific contact pressure. If the test article simply has a substantially cylindrical wall, this pressure can also serve to close the second opening of the test article, which is opposite the floor of the test chamber and is associated there with suitable sealing means. If, however, the test article has relatively unstable walls, then the plunger is preferably hollow and designed to receive a rod by which locking means associated with the sealing element can be actuated.

The above and other features and advantages of the invention will now be described in more detail with reference to the accompanying drawings in which:—

Figure 1 is a section through an embodiment of an apparatus suitable for carrying out the method according to the invention;

Figure 2 is a section through a connection device included in the apparatus of Figure 1, and

Figure 3 illustrates another embodiment of apparatus according to the invention suitable for test articles having approximately cylindrical walls, and two openings situated opposite one another.

The embodiment illustrated in Figures 1 and 2 comprises a test chamber 1 formed by a fixed floor 2 and a hood 4 mounted thereon in a vacuum-tight manner by means of a seal 3. A vacuum pump 6 is connected to the floor of the chamber via a valve 5, and a test gas detector 8, shown diagrammatically, is connected to the floor of the chamber via a valve 7. A rotatable shaft 9 also passes in a gas-tight manner through the floor 2 and carries on the inside of the test chamber 1, a plate 10 with ribs 11 for attaching the test article 12 which has an opening 22 therein. The ribs enable the integral leak detection procedure to cover as well the bottom surface of the test article 12.

A closure device generally denoted by the reference numeral 13 is provided in the upper wall of the hood 4 and consists of a plunger 15 passing, by means of a seal 14, in a vacuum-tight manner through the hood 4, and an actuating device consisting of a piston 16 and a cylinder 17. A test gas source 19, shown diagrammatically, is connected to the hollow plunger 15 via a valve 18. In addition, in the embodiment illustrated a compressed gas source 20*a* (gas free from test gas) is also connected via a valve 20. At its lower end the plunger 15 carries a flange-type sealing element 21 by means of which the opening 22 of the test article 12 can be sealed with respect to the remaining contents of the test chamber 1. At the same time a connection is made between the interior of the test article 12 and the lines leading to the test gas source 19 or compressed gas source 20*a*.

The integral leak detection can be made with the apparatus illustrated in the following way:

The test article 12 is placed on the plate 10 in a manner that will not be described in more detail (conveniently by means of an automatically operating transfer device) and the hood 4 is then placed over the test article 12 to form the closed test chamber. The plunger 15 is in its upper position. The valves 5, 7, 18 and 20 are thus closed. Immediately after the test chamber has been closed, the valve 5 is opened so that the test article 12 and the test chamber 1 are simultaneously evacuated. If necessary, during this time the opening 22 of the test article 12 can be aligned with the closure device 13 of the sealing element 21 by rotating the plate 10. When the pressure level at which the test gas is to be admitted is reached in the interior of the test article, the plunger 15 moves downwardly and thus separates the interior of the test article 12 from the remaining interior of the test chamber 1. The valve 5 is then still left open for the time required to produce the necessary vacuum for the leak detection test in the test chamber. The valve 5 is then closed and the valve 18 is opened to admit test gas into the test article 12. At the same time compressed gas can be

variable height and width, having substantially cylindrical walls.

CLAIMS

1. A method of testing the integrity of a hollow article by a leak detection procedure, the article having an opening therein, which comprises placing the article in a test chamber with the opening exposed, evacuating the test chamber and hence also the interior of the article, operating a closure device from outside the chamber to close the opening and seal the space inside of the article from the remaining space in the chamber surrounding the article, continuing evacuation of one of said spaces to produce a pressure differential between said spaces and across the wall of the article, admitting a test gas to the space at the higher pressure, and connecting a test gas detector to the space at the lower pressure to test for the presence of test gas therein.

2. A method according to Claim 1, wherein the closure device affords a means for admitting test gas to, or for connecting the test gas detector to, the space inside the article.

3. A method according to Claim 1 or 2, wherein in order to ventilate the test chamber and article after the leak detection test, the differential pressure is first equalised, the interior of the test article is connected to the interior of the test chamber, and then both spaces are simultaneously ventilated.

4. Apparatus for testing the integrity of a hollow article by a leak detection procedure according to the method claimed in any one of Claims 1 to 3, the article having an opening therein comprising a test chamber accommodating an article to be tested, means for evacuating the test chamber, a closure device within the test chamber operable to close the opening in the article and thereby seal the space inside the article from the remaining space in the chamber surrounding the article, means operable from outside the test chamber for actuating the closure device, means for admitting a test gas to one of said spaces and a test gas detector connectible to the other of said spaces.

5. Apparatus according to Claim 4, wherein the closure device also provides a passageway for communicating with the interior of the test article.

6. Apparatus according to Claim 4 or 5, wherein the test chamber comprises a floor and a removable hood mounted on the floor, and the closure device is arranged on the said hood.

7. Apparatus according to Claim 6, wherein the evacuating means is connected to the floor of the test chamber.

8. Apparatus according to Claim 7, wherein a connection for admitting test gas is provided on the floor of the test chamber and the closure device is connected to the test gas detector.

9. Apparatus according to Claim 7, wherein the test gas detector is connected to the floor of the test chamber and the closure device is connected to a source of test gas source.

10. Apparatus according to claim 9, wherein the closure device is additionally connected to a storage vessel for a compressed gas free from test gas.

11. Apparatus according to any one of Claims 4 to 10, wherein the closure device comprises a plunger passing in a gas-tight manner through the wall of the test chamber, the said plunger having a flange-type sealing element for engaging with the test article.

12. Apparatus according to Claim 11, wherein the plunger is hollow and a rod for operating locking means associated with the sealing element is accommodated in said plunger.

13. Apparatus according to Claim 12, wherein the locking means comprise levers for introduction into the opening in the test article, the levers being expandable outwardly by means of the rod.

14. Apparatus according to any one of Claims 11 to 13, comprising double seals spaced apart to provide an evacuable intermediate space therebetween or provided to seal the plunger with respect to the hood and/or to seal the sealing element with respect to the test article.

15. Apparatus according to Claim 14, wherein the plunger is double-walled and the evacuation of the intermediate space is effected via the passage formed by the double wall.

16. Apparatus according to any one of Claims 6 to 15, wherein the floor of the test chamber has sealing means for sealingly closing a second oppositely positioned opening in a substantially cylindrical test article.

17. Apparatus according to Claim 16, wherein the sealing means consist of a sealing ring let into the floor of the test chamber.

18. An apparatus according to Claim 16 or 17, wherein the floor has a moulded body arranged to project into the substantially cylindrical test article.

19. Apparatus according to any one of the preceding claims, wherein the closure device of the test chamber is connected to means for admitting a scavenging gas.

20. A method of testing the integrity of a hollow article by a leaks detection procedure according to Claim 1 and substantially as hereinbefore described.

21. Apparatus for testing the integrity of a hollow article by a leak detection procedure substantially as hereinbefore described with reference to the accompanying drawings.

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